Glossary

Abatement—any set of measures designed to permanently correct and eliminate lead-based paint hazards. Abatement includes the *removal* of lead-based paint and lead-contaminated dust, the *permanent containment* or *encapsulation* of lead-based paint, the *replacement* of lead-painted surfaces or fixtures, and the removal or covering of lead contaminated soil. Abatement also includes all preparation, clean-up, worker protection, disposal, and post-abatement clearance testing activities associated with such measures.

Accessible Surface—an interior or exterior surface that is accessible for a young child to mouth or chew.

Common Areas—a room or area that is accessible to all tenants in a building or development (e.g., hallway, vestibule).

Comprehensive Testing—the systematic inspection of a housing development for the presence of lead-based paint using x-ray fluorescence (XRF) equipment to screen building components and laboratory analysis of paint samples where XRF readings are inconclusive.

Defective Paint Surface—paint which is cracking, flaking, chipping or peeling from a building component (e.g., window sill, door or door frame, etc.).

Family Development—a development assisted under the U.S. Housing Act of 1937 (other than section 8 or 17 of the Act) which is not an elderly project. For this purpose, an elderly project is one which was designated for occupancy by the elderly at its inception (and has retained that character) or, although not so designated, for which the PHA gives preference in tenant selection (with Department of Housing and Urban Development approval for all units in the development to elderly families. A building within a mixed-use development which meets these qualifications shall, for purposes of this document, be excluded from any family development.

High Efficiency Particle Air (HEPA) Filter—a filter capable of filtering out particles of 0.3 microns or greater from a body of air at 99.97% efficiency or greater.

In-Place Management—a process in which a housing authority will take to reduce excessive exposures to lead and protect occupants from lead poisoning in units pending abatement.

Inspection—determines the condition of paint on a surface and the condition of the painted surface.

Lead-Based Paint Hazard—paint or other surface coatings that contain lead in excess of limits established by the Department of Housing and Urban Development.

Lead in Dust—interior house surface dust that contains an area mass concentration of lead which may pose a threat of adverse health effects in pregnant women or young children.

Lead in Soil—accessible soil on residential real property that contains lead in excess of the level determined to be safe by the appropriate Federal agency.

Multi-Unit Structures—residential buildings/dwelling units within a development which have a similar style of construction and similar paint history. Factors that contribute to similar paint history are common ownership from time of construction; similar occupancy patterns since construction; similar configuration and construction materials; and are conterminous (having a common boundary).

Random Testing—a surface-by-surface investigation of intact and non-intact interior and exterior painted surfaces in selected housing units for lead-based paint using an approved x-ray fluorescence analyzer or comparable approved sampling or testing technique.

Risk Assessment—an on-site investigation, including sampling in housing constructed prior to 1978, to determine the existence and extent of lead-based paint hazards and physical conditions that could potentially affect the integrity of painted surfaces.

Scattered Site Housing—residential buildings/dwelling units which have different styles of construction and unknown and unmanaged paint histories. Factors that contribute to unknown and unmanaged paint histories are multiple ownerships from time of construction; multiple occupancy patterns since construction; different configurations and construction materials; and are not conterminous (having no common boundary).

Visual Inspection—a surface-by-surface investigation of intact and non-intact interior and exterior painted surfaces.

Window Sill—the building component forming the lower side (bottom) of a window opening.

Window Stool—the flat horizontal molding fitted over the sill, on the window interior, between jambs, which comes in contact with the bottom rail of the (lower) operating sash, and the window sill.

Window Well—the horizontal area of the window sill that comes in contact with the bottom rail of the operating sash (when closed), and the window stool.

Worst Case—units, common areas, and exteriors which are suspected to contain lead-based paint. Worst case units, common areas, and exteriors surfaces are usually in poor physical condition and poorly maintained. In this document, worst case also means units, common areas, and exteriors which are randomly selected for testing and inspection.

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June 29, 1992

Part III

Department of Transportation

Federal Aviation Administration

14 CFR Part 25

Vibration, Buffet and Aeroelastic Stability Requirements for Transport Category Airplanes; Final Rule

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. 26007; Amdt. No. 25-77]

RIN: 2120-AD36

Vibration, Buffet and Aeroelastic Stability Requirements for Transport Category Airplanes

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This amendment revises the airworthiness standards of the Federal Aviation Regulations (FAR) for type certification of transport category airplanes concerning vibration, buffet, flutter and divergence. It clarifies the requirement to consider flutter and divergence when treating certain damage and failure conditions required by other sections of the FAR and adjusts the safety margins related to aeroelastic stability to make them more appropriate for the conditions to which they apply. These changes are made to provide consistency with other sections of the FAR and to take into account advances in technology and the evolution of the design of transport airplanes.

EFFECTIVE DATE: July 29, 1992.

FOR FURTHER INFORMATION CONTACT: James Haynes, Airframe and Propulsion Branch (ANM-112), Transport Airplane Directorate, Aircraft Certification Service, FAA, 1601 Lind Avenue SW., Renton, Washington 98055-4056, telephone (206) 227-2131.

SUPPLEMENTARY INFORMATION:

Background

The term "aeroelastic" is applied to an important class of phenomena which involves the mutual interaction between the inertial, aerodynamic, and elastic forces in a structure. These forces can interact to give rise to a variety of aeroelastic phenomena ranging from transient or dynamic responses as a result of external forces (vibration or buffeting) to aeroelastic instabilities (flutter or divergence). The importance distinction between response and instability phenomena is that instabilities are self-excited, that is, they can exist even in smooth air in the absence of any external forces. A slight perturbation of the structure at or above the critical airspeed is all that is needed to initiate the unstable condition which then may be maintained or grow to destructive proportions in the absence of any external forces.

Few aeroelastic phenomena fit neatly into classifications where exact definitions can be considered to apply without qualification. The following definitions should be considered to apply to classical aeroelastic phenomena and used with a certain amount of judgment since not even the experts in the field would agree completely on any set of definitions.

1. *Vibration.* An oscillation of the structure or of a control surface resulting from an independent external excitation.

2. *Buffeting.* A random oscillation of the structure resulting from unsteady aerodynamic forces, usually associated with separated airflow.

3. *Flutter.* The unstable self-excited structural oscillation at a definite frequency where energy is extracted from the airstream by the motion of the structure. The deformation and motion of the structure result in forces on the structure that tend to maintain or augment the motion. The displacement modes associated with flutter instabilities are sometimes called "flutter modes."

4. *Whirl Flutter.* Flutter in which the aerodynamic and gyroscopic forces associated with rotations and displacements in the plane of a propeller or large turbofan play an important role. The displacement modes associated with whirl flutter are sometimes called "whirl modes."

5. *Divergence.* A static instability at a speed where the aerodynamic forces resulting from the deformation of the structure exceed the elastic restoring forces resulting from the same deformation.

6. *Control Reversal.* A condition generally occurring at higher speeds in which the intended effects of displacing a given component of the control system are completely overcome by the aeroelastic effects of structural deformation, resulting in reversed command.

7. *Deformation Instability.* The loss of airplane stability and control as a result of the aeroelastic effects of structural deformation.

Many of the above terms have been used in the airworthiness regulations and associated advisory material for many years and there is no intent to redefine these phenomena or require consideration of new phenomena by this amendment.

This amendment is based on Notice of Proposed Rulemaking (NPRM) No. 89-24 which was published in the **Federal Register** on September 12, 1989, (54 FR 37768). The notice proposed to revise and update the requirements concerning vibration, buffet, and aeroelastic stability to make these requirements more consistent with modern transport airplane designs. It was proposed to augment the list of failures, malfunctions and adverse conditions by including additional damage and failure conditions that have been added to other sections of the FAR. In addition, the FAA proposed in the NPRM to revise the safety margins for aeroelastic stability to make them more appropriate for the conditions to whch they applied and more consistent with advances in technology of transport airplane design. Additional proposals were to reorganize certain requirements so that structural load requirements, flight requirements, and aeroelastic stability requirements would be set forth in the proper sections and subparts of part 25.

In the 1940's, when the first transport airplane flutter and divergence requirements were introduced, a safety margin was established by requiring that the airplane be designed to be free from flutter and divergence at an airspeed 20 percent greater than the maximum design dive speed. Flutter analyses, using the available theoretical methods of that time, were used to show compliance. The 20 percent margin was intended to account for the inaccuracy in the analytical prediction of the flutter speed, as established by those early methods, and to provide for production and service variations. The ability of the industry to substantiate freedom from flutter and other aeroelastic instability phenomena has been continually improving. Current analytical methods employ finite element solutions with advanced unsteady aerodynamic theories and can accommodate airplanes of complex configurations. In addition, model testing, ground vibration testing and flight flutter testing techniques have all undergone significant improvements. Complete airplane experimental modal analyses are now commonplace. Furthermore, the cost of these analytical methods and testing techniques has been kept reasonable by the advances in computer technology. Because of these improvements, the FAA proposed in Notice 89-24 to reduce the 20 percent margin to 15 percent.

Part 25 has been continually upgraded with failure and damage requirements in other sections. Among these requirements are the criteria for complete loss of all engines in § 25.671, the empennage bird strike criteria of § 25.631, and the discrete source damage criteria of § 25.571(e). These sections generally require "no catastrophic failure" or "safe flight and landing" or similar provisions in the event of

specified failure conditions. These regulations have been interpreted to require flutter substantiation if the failure or damage event could have a significant effect on the flutter modes. In Notice 89–24 the FAA proposed to amend § 25.629 to directly reference many of these requirements to make it clear that freedom from aeroelastic instability is required to be demonstrated for these additional failure and damage conditions.

The design margin for the fail-safe design conditions has been the margin between design cruise speed, V_C/M_C and design dive speed, V_D/M_D. This margin originally was 25 percent, but has since been reduced by the incorporation of an upset criterion to establish V_D/M_D (§ 25.335(b)). This criterion generally results in a margin of between 15 and 20 percent on modern conventional transport airplanes at altitudes where V_C is not limited by Mach number. One recent airplane design incorporating a speed protection system would have resulted in even lower margins had the FAA not issued a special condition requiring that this margin be at least 15 percent. In Notice 89–24 the FAA proposed that the fail-safe margin not be allowed to be lower than 15 percent for the fail-safe design conditions. However, further adjustments in the margin were proposed for altitudes where design speeds are limited by Mach number.

Discussion of Comments

Comments were received from foreign and domestic airplane manufacturers, foreign airworthiness authorities, airplane operator and manufacturer trade groups, pilots associations and private individuals. The majority of commenters express support for the proposals, especially in regard to the attempt to modernize the requirements and adjust the safety margins so that they are more appropriate for modern transport airplane designs and take into consideration modern technology. As a result of the comments, several changes were made to the proposals to improve their organization and clarity.

One commenter suggests that the references to § 25.1309 and the use of the phrase "extremely improbable" in the proposed rule be accompanied with a numerical probability value. The phrase "extremely improbable" was contained in the previous rule and was not a new proposal in the NPRM. Acceptable methods of compliance are described in FAA Advisory Circular 1309–1A, System Design and Analysis. However, the FAA appreciates the commenter's desire for specific compliance criteria and is currently assessing the need for additional advisory material to treat failure analyses as they relate to flutter. If additional guidance is found necessary, it will be included in the appropriate advisory circular.

The same commenter suggests that the requirement concerning oscillatory failures in the proposed § 25.305(f) was more restrictive than the current requirement. The commenter believes that the requirement for the resulting loads to be considered as limit load conditions is an increase in the current requirements and not consistent with conditions related to failures which should be treated as ultimate conditions.

The FAA disagrees. Limit loads (the maximum loads to be expected in service) are required to be sustained without permanent deformation of the structure. Ultimate loads are loads that are required to be sustained without failure, although permanent deformation is allowed. Section 25.301(a) states that all loads prescribed in the FAR are limit loads unless otherwise specified. Only loads from certain failure conditions, as specified by the regulations, are allowed to be treated as ultimate load conditions. These are generally load conditions that are independent of the failure event and not likely to be achieved during the time the failure exists. However, the oscillatory load condition concerns loads that result directly from the failure itself and involve a repetition of these loads at a rapid frequency. These loads have historically been treated as limit loads, and this amendment merely clarifies the requirement that this failure condition is to be treated as a limit load condition.

Several commenters object to the provisions relating to damage tolerance contained in paragraphs § 25.629(d)(2)(i) and (ii) of the NPRM, which were intended to provide a means of establishing the necessity for considering single failures of engine structures, engine mounts, and supports for external bodies, propellers or rotating machinery. The commenters believe that it is inappropriate to establish damage tolerance criteria in § 25.629 that are different and could be more restrictive than § 25.571 which specifically covers damage tolerance evaluation. The FAA agrees, and the paragraphs have been revised to provide relief from the single failure requirement for these structures if an analysis under § 25.571(b) and 25.571(e) indicate that consideration of a single failure is unnecessary for meeting those requirements. For the purposes of organizational clarity, this revised requirement is consolidated with § 25.629(d)(3)(ix) of the proposal, which also referred to § 25.571, and set forth in § 25.629(d)(8) of this amendment. Further consolidation of the proposed §§ 25.629(d)(3)(viii) and 25.629(d)(3)(ix) resulted in § 25.629(d)(9) of this amendment.

Several commenters suggest that a specific minimum damping value be provided in the rule to define a proper margin of damping for aeroelastic modes; however, no suggestions for specific criteria were provided. The current Advisory Circular (AC) 25.629–1, Flutter Substantiation of Transport Airplanes, provides guidance relative to establishing a proper margin of damping which depends on the analytical methodology and on the general character of the aeroelastic mode. It is not practicable to establish a regulatory requirement for a specific damping margin that would be appropriate in all cases.

The majority of commenters express support for the change in the flutter substantiation speed margin from 1.2 V_D to 1.15 V_D. However, several commenters are concerned that the modern analytical methods, which they believed to be the basis for making this reduction, are not mandated by regulation nor necessarily practiced by all manufacturers. As discussed previously, the reduction was not proposed as a result of improvements in analytical methodology alone; but is also attributable to improved testing methods and improvements in other related requirements. Furthermore, an analytical speed margin alone does not in itself provide a guarantee of freedom from flutter regardless of its actual value. This is because many modes can become critical well within the flight envelope by only small changes in other parameters. An extensive parametric investigation to establish sensitivities and to develop a proper margin with respect to all important parameters (altitude, air forces, rigidity, mass balance, etc.) is an essential part of any aeroelastic investigation. This is a required certification practice for transport airplanes with respect to flutter substantiation as explained in AC 25.629–1.

Furthermore, the analytical speed margins required by the previous regulation were inconsistent with the accuracy associated with predicting flutter for the various conditions. For modern transport category airplanes, the 20 percent margin was required for the nominal (unfailed) airplane at the lower altitudes and these are the most reliable conditions to analyze. However, the analytical speed margins for the

nominal airplane at altitudes where operating speed is limited by Mach number, and for failure cases at any altitude, were permitted to be much less than 20 percent even though aeroelastic instabilities for these conditions are less reliably predicted. This amendment establishes a more consistent speed margin for all conditions including failure cases.

Another commenter suggests that the change in the speed margin should not be allowed as long as the FAA accepts the traditional "strip theory" method of flutter analysis and does not mandate the more recently developed "doublet-lattice" method which the commenter asserts to be more reliable. Since all analytical methods have deficiencies with respect to certain configurations, the FAA prefers not to mandate specific theoretical methods by regulation. In many cases, more than one analytical method may be necessary in order to overcome deficiencies that a particular method might have with specific configurations. It is necessary that any analytical methodology used for flutter substantiation be validated for the specific application and be shown to reliably predict the aeroelastic characteristics of the airplane. This validation is normally based on correlation with actual test data such as wind tunnel data, ground vibration test data, and flight test results. Guidance pertaining to validation of analytical methodology is contained in AC 25.629–1.

One commenter states that the requirement to consider mismanagement of fuel conditions is considerably beyond the normal design practices. The FAA disagrees since consideration of fuel mismanagement conditions has been a standard practice for many years, and, in fact, although not explicitly listed, has been considered necessary in showing compliance with § 25.629. The new rule makes this condition explicit by adding it to the list of failure and adverse conditions so that it cannot be overlooked.

Another commenter suggests that the requirement for the treatment of whirl flutter should include a specific requirement to consider the influence of a non-uniform airstream on propellers installed in a pusher configuration. The general objective language, as proposed, is sufficient for requiring these considerations. These analytical details will be considered for inclusion in the appropriate advisory circular.

The same commenter also points out that, in addition to pitch and yaw rigidity, the translational rigidity of propeller axes can also be important for certain configurations. The FAA agrees and paragraph (d)(5) has been revised to delete the words "pitch and yaw" so that it addresses "rigidity" in general.

One commenter suggests that the consideration of single failures in flutter damper systems should not be required if they can be shown to be extremely improbable. The FAA disagrees; this single failure requirement already existed in the previous regulation and was intended to provide a single failure requirement for passive flutter dampers, equivalent to that already provided in § 25.671(c)(1) for flight control systems. Although flutter dampers are typically mechanical components, similar in design and criticality to mechanical control system components, they may not necessarily be considered part of the flight control system. Therefore, it is necessary to provide a separate single failure requirement for them in § 25.629(d).

One additional change was to delete a statement in the proposal that provided for substantiation of the failure and damage events by showing that losses in rigidity or changes in frequency, mode shape, or damping are within the parameter investigations shown to be satisfactory in the flutter and divergence investigations. While there is no intent to eliminate this approach as an acceptable means of compliance, the FAA considers it unnecessary to prescribe it in the regulations. This method of compliance is specifically provided for in AC 25.629–1.

Regulatory Evaluation

This section summarizes the full regulatory evaluation prepared by the FAA that provides more detailed estimates of the economic consequences of this regulatory action. This summary and the full evaluation quantify, to the extent practicable, estimated costs to the private sector, consumers, Federal, State and local governments, as well as anticipated benefits.

Executive Order 12291, dated February 17, 1981, directs Federal agencies to promulgate new regulations or modify existing regulations only if potential benefits to society for each regulatory change outweigh potential costs. The order also requires the preparation of a Regulatory Impact Analysis of all "major" rules except those responding to emergency situations or other narrowly defined exigencies. A "major" rule is one that is likely to result in an annual increase in consumer costs, a significant adverse effect on the economy of $100 million or more, a major increase in consumer costs, a significant adverse effect on competition, or is highly controversial.

The FAA has determined that this rule is not "major" as defined in the executive order, therefore a full regulatory analysis, that includes the identification and evaluation of cost reducing alternatives to this rule, has not been prepared. Instead, the agency has prepared a more concise document termed a regulatory evaluation that analyzes only this rule without identifying alternatives. In addition to a summary of the regulatory evaluation, this section also contains a regulatory flexibility determination required by the Regulatory Flexibility Act of 1980 (Pub. L. 96–354) and an international trade impact assessment. If more detailed economic information is desired than is contained in this summary, the reader is referred to the full regulatory evaluation in the docket.

Economic Evaluation

This rule applies to manufacturers of airplanes built to part 25 standards. It will have no impact, positive or negative, on the level of safety associated with the operation of transport category airplanes. It will provide a limited, but undetermined, amount of cost savings to manufacturers by reducing the design margin for airspeed. Another benefit of the rule is that it will update, reorganize and clarify the intent of various sections within part 25 concerning vibration, buffet, flutter and divergence. Since no increase in cost is associated with this rule, and since there are benefits of the rule associated with cost reduction to transport airplane manufacturers, and improved organization, consistency, and clarity within part 25, this rule is cost-effective.

The following table summarizes each of the changes and briefly assesses their economic impact.

Changes	Economic impact
Creates § 25.305(e). Incorporates the design requirements of § 25.251(a) into § 25.305. Clarifies that freedom from vibration need not be demonstrated under failure conditions.	Clarifies intent of rule and improves organization of regulations. No economic impact.

Changes	Economic impact
Reorganizes contents of § 25.629 regarding the evaluation of loads into a new (and more pertinent) § 25.305(f).	Clarifies intent of the rule. No economic impact.
Changes the title of § 25.629.	Editorial change. No economic impact.
Differences between propellers or similar rotating devices that contribute "significant dynamic forces," and those that do not.	Clarifies intent of the rule. No economic impact.
Reduces the design margin for airspeed from 20 percent to 15 percent to reflect modern technology and aircraft.	Relieves manufacturers of need to meet unnecessary design capabilities. Provides a reduction of costs.
Provides a minimum speed margin or floor for aeroelastic stability analysis	Provides a fixed minimum safety margin equivalent to the minimum applied to conventional designs in order to facilitate the use of new technology equipment such as speed protection systems. Cost saving can result from the use of the new technology equipment. Otherwise, no economic impact.
Adds mismanagement of fuel and bird strike incidence to the failure, malfunction, damage and adverse conditions of § 25.626(d).	Consolidates existing requirements. No economic impact.
Requires aeroelastic analysis of any combination of feathered propellers	Resolves inconsistencies in regulations. No economic impact.
Permits the use of damage tolerance requirements of § 25.571(b) for evaluating structures, thus eliminating current confusion.	Clarifies the meaning of the regulation. No economic impact.
Requires full scale flight flutter tests for new designs	Clarifies the means of demonstrating compliance with existing requirements.

International Trade Impact Assessment

This rule will have little or no impact on the trade opportunities for both U.S. firms doing business in foreign countries and foreign firms doing business in the United States. If foreign nations do not adopt U.S. standards, their manufacturers may be at a disadvantage in the U.S. market. However, the impact is expected to be slight. If foreign manufacturers do adopt U.S. standards, U.S. manufacturers selling abroad could continue to design to foreign standards which would also meet U.S. standards.

Regulatory Flexibility Determination

Under the criteria of the Regulatory Flexibility Act of 1980 and FAA Order 2100.14A, (*Regulatory Flexibility Criteria and Guidance*), the FAA has determined that the rule will not have a significant economic impact on a substantial number of small entities. Only U.S. manufacturers of transport category airplanes will be affected, and none of the transport category airplane manufacturers in the United States meets the criteria of a small entity.

Federalism Implications

The regulations adopted herein do not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that such a regulation does not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

Because the requirement to consider flutter and divergence when testing certain damage and failure conditions required by the FAR is not expected to result in a substantial cost, the FAA has determined that this final rule is not major as defined in Executive Order 12291. This final rule is considered to be significant as defined in Department of Transportation Regulatory Policies and Procedures (44 FR 11034, February 26, 1979). In addition, since there are no small entities affected by this rulemaking, it is certified, under the criteria of the Regulatory Flexibility Act, that this final rule, at promulgation, will not have a significant economic impact, positive or negative, on a substantial number of small entities. A copy of the final regulatory evaluation prepared for this project may be examined in the public docket or obtained from the person identified under the caption "For Further Information Contact."

List of Subjects in 14 CFR Part 25

Air transportation, Aircraft, Aviation safety, Safety.

The Amendment

Accordingly, 14 CFR part 25 of the Federal Aviation Regulations (FAR) is amended as follows:

PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

1. The authority citation for part 25 continues to read as follows:

Authority: 49 U.S.C. 1344, 1354(a), 1355, 1421, 1423, 1424, 1425, 1428, 1429, 1430, 49 U.S.C. 106(g) and 49 CFR 1.47(a).

2. By amending § 25.251 by revising paragraphs (a) and (b) to read as follows:

§ 25.251 Vibration and buffeting.

(a) The airplane must be demonstrated in flight to be free from any vibration and buffeting that would prevent continued safe flight in any likely operating condition.

(b) Each part of the airplane must be demonstrated in flight to be free from excessive vibration under any appropriate speed and power conditions up to V_{DF}/M_{DF}. The maximum speeds shown must be used in establishing the operating limitations of the airplane in accordance with § 25.1505.

* * * * *

3. By amending § 25.305 by adding new paragraphs (e) and (f) to read as follows:

§ 25.305 Strength and deformation.

* * * * *

(e) The airplane must be designed to withstand any vibration and buffeting that might occur in any likely operating condition up to V_D/M_D, including stall and probable inadvertent excursions beyond the boundaries of the buffet onset envelope. This must be shown by analysis, flight tests, or other tests found necessary by the Administrator.

(f) Unless shown to be extremely improbable, the airplane must be designed to withstand any forced structural vibration resulting from any failure, malfunction or adverse condition in the flight control system. These must be considered limit loads and must be investigated at airspeeds up to V_C/M_C.

4. By revising § 25.629 to read as follows:

§ 25.629 Aeroelastic stability requirements.

(a) *General.* The aeroelastic stability evaluations required under this section include flutter, divergence, control reversal and any undue loss of stability and control as a result of structural deformation. The aeroelastic evaluation must include whirl modes associated with any propeller or rotating device that contributes significant dynamic forces. Compliance with this section must be shown by analyses, wind tunnel tests, ground vibration tests, flight tests, or other means found necessary by the Administrator.

(b) *Aeroelastic stability envelopes.* The airplane must be designed to be free

from aeroelastic instability for all configurations and design conditions within the aeroelastic stability envelopes as follows:

(1) For normal conditions without failures, malfunctions, or adverse conditions, all combinations of altitudes and speeds encompassed by the V_D/M_D versus altitude envelope enlarged at all points by an increase of 15 percent in equivalent airspeed at both constant Mach number and constant altitude. In addition, a proper margin of stability must exist at all speeds up to V_D/M_D and, there must be no large and rapid reduction in stability as V_D/M_D is approached. The enlarged envelope may be limited to Mach 1.0 when M_D is less than 1.0 at all design altitudes, and

(2) For the conditions described in § 25.629(d) below, for all approved altitudes, any airspeed up to the greater airspeed defined by;

(i) The V_D/M_D envelope determined by § 25.335(b); or,

(ii) An altitude-airspeed envelope defined by a 15 percent increase in equivalent airspeed above V_C at constant altitude, from sea level to the altitude of the intersection of 1.15 V_C with the extension of the constant cruise Mach number line, M_C, then a linear variation in equivalent airspeed to $M_C + .05$ at the altitude of the lowest V_C/M_C intersection; then, at higher altitudes, up to the maximum flight altitude, the boundary defined by a .05 Mach increase in M_C at constant altitude.

(c) *Balance weights.* If concentrated balance weights are used, their effectiveness and strength, including supporting structure, must be substantiated.

(d) *Failures, malfunctions, and adverse conditions.* The failures, malfunctions, and adverse conditions which must be considered in showing compliance with this section are:

(1) Any critical fuel loading conditions, not shown to be extremely improbable, which may result from mismanagement of fuel.

(2) Any single failure in any flutter damper system.

(3) For airplanes not approved for operation in icing conditions, the maximum likely ice accumulation expected as a result of an inadvertent encounter.

(4) Failure of any single element of the structure supporting any engine, independently mounted propeller shaft, large auxiliary power unit, or large externally mounted aerodynamic body (such as an external fuel tank).

(5) For airplanes with engines that have propellers or large rotating devices capable of significant dynamic forces, any single failure of the engine structure that would reduce the rigidity of the rotational axis.

(6) The absence of aerodynamic or gyroscopic forces resulting from the most adverse combination of feathered propellers or other rotating devices capable of significant dynamic forces. In addition, the effect of a single feathered propeller or rotating device must be coupled with the failures of paragraphs (d)(4) and (d)(5) of this section.

(7) Any single propeller or rotating device capable of significant dynamic forces rotating at the highest likely overspeed.

(8) Any damage or failure condition, required or selected for investigation by § 25.571. The single structural failures described in paragraphs (d)(4) and (d)(5) of this section need not be considered in showing compliance with this section if:

(i) The structural element could not fail due to discrete source damage resulting from the conditions described in § 25.571(e), and

(ii) A damage tolerance investigation in accordance with § 25.571(b) shows that the maximum extent of damage assumed for the purpose of residual strength evaluation does not involve complete failure of the structural element.

(9) Any damage, failure, or malfunction considered under §§ 25.631, 25.671, 25.672, and 25.1309.

(10) Any other combination of failures, malfunctions, or adverse conditions not shown to be extremely improbable.

(e) *Flight flutter testing.* Full scale flight flutter tests at speeds up to V_{DF}/M_{DF} must be conducted for new type designs and for modifications to a type design unless the modifications have been shown to have an insignificant effect on the aeroelastic stability. These tests must demonstrate that the airplane has a proper margin of damping at all speeds up to V_{DF}/M_{DF}, and that there is no large and rapid reduction in damping as V_{DF}/M_{DF}, is approached. If a failure, malfunction, or adverse condition is simulated during flight test in showing compliance with paragraph (d) of this section, the maximum speed investigated need not exceed V_{FC}/M_{FC} if it is shown, by correlation of the flight test data with other test data or analyses, that the airplane is free from any aeroelastic instability at all speeds within the altitude-airspeed envelope described in paragraph (b)(2) of this section.

Issued in Washington, DC, on June 22, 1992.

Barry Lambert Harris,

Acting Administrator.

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Monday
June 29, 1992

Part IV

Department of Transportation

Federal Aviation Administration

14 CFR Part 147

Revision of Aviation Maintenance Technician Schools Regulations; Final Rule

DEPARTMENT OF TRANSPORTATION

14 CFR Part 147

[Docket No. 26331; Amendment No. 147-5]

RIN 2120-AD09

Revision of Aviation Maintenance Technician Schools Regulations

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This amendment updates the regulations for certificating Aviation Maintenance Technician Schools (AMTS) to accommodate the increasing demand for maintenance technicians with higher levels of skill and knowledge. The amendment modifies portions of the rule that have been open to subjective judgments by the FAA and the AMTS industry and modifies the portions that specify the skill and knowledge requirements for an aviation maintenance technician. This amendment revises the core curriculum to ensure that AMTS graduates will be prepared to function in the current technological environment.

EFFECTIVE DATE: September 28, 1992.

FOR FURTHER INFORMATION CONTACT: Leslie K. Vipond, AFS-302, Aircraft Maintenance Division, Flight Standards Service, Federal Aviation Administration, 800 Independence Avenue, SW., Washington, DC 20591, telephone (202) 267-3269.

SUPPLEMENTARY INFORMATION:

Background

Part 147 (14 CFR part 147) was adopted in 1970 and, except for some minor changes, has not been revised since that time. The civil aviation environment in which the aviation maintenance technician operates has changed significantly since that regulation was adopted. Thus, a person could graduate from a part 147-approved AMTS and not be fully prepared to function in the current aviation environment.

In keeping with FAA policy to review and upgrade regulations to ensure that they are consistent with changes in the aviation environment, the FAA contacted the airlines, AMTS, repair stations, and mechanic organizations to consider holding joint industry/FAA public listening sessions to discuss proposed changes. The FAA held a series of three public listening sessions in 1988 and received significant input from the aviation industry. The first session was held in Atlanta, Georgia, on August 29-30, 1988; the second was held in Oklahoma City, Oklahoma, on September 8-9, 1988; and the third was held in San Jose, California, on September 15-16, 1988. The agenda of the listening sessions was based on questions from the AMTS and the airline industry. Information obtained during the listening sessions formed a basis for an outline of certain proposed changes for the rule. After the sessions, the FAA determined it was appropriate to consider modifications of the portions of the rule that govern AMTS curriculum, administration, and operating rule requirements. The FAA then developed and issued a notice of proposed rulemaking (NPRM) to amend part 147 (55 FR 37416, September 11, 1990, Docket No. 26331, Notice No. 90-22).

This NPRM addressed and included proposals from both industry and the FAA. The notice was comprehensive and contained proposed revisions to nearly every section of part 147. All interested persons were given an opportunity to comment on the proposals and due consideration has been given to all comments received.

Discussion of Comments

The FAA received 41 comments in response to the NPRM. These comments have been reviewed and considered by the FAA in the promulgation of this final rule. Twelve large industry groups, representing over 10,000 aviation businesses, corporations, AMTS, and individuals, enthusiastically support the NPRM. These groups, including the Aviation Technician Education Council, Air Transport Association of America, National Business Aircraft Association, and Professional Aviation Maintenance Association, participated in the public listening sessions and helped to identify important areas of reform early in this process. Essentially, their comments consist of general statements favoring all aspects of the NPRM, with some minor suggestions. The remaining commenters consist of individuals who perform aircraft maintenance or schools involved in training. The comments are summarized and discussed below on a section-by-section basis. Only those sections commented upon are discussed.

Section 147.5(a) Application and Issue

The proposal to amend § 147.5(a), by removing the requirement of listing the subjects to be taught by each instructor and the requirement that applicants submit photographs of the facilities, received no adverse comments.

One commenter suggests that the section of the rule requiring that specialized instructors be listed by name be changed so they may be listed simply as "staff" to reduce administrative costs. No additional clarifying information was submitted concerning this suggestion, nor did the commenter provide any economic data to support the comment. Accordingly, § 147.5(a) is adopted as proposed.

Section 147.15 Space Requirements

This section of the proposal removes the requirement for separate classroom and shop space, thus, providing schools with more flexibility in use of classroom and laboratory areas.

One commenter recommends that § 147.15(f) retain the words "assemble and test." No additional clarifying information was submitted concerning this suggestion.

The FAA has determined that the words "assemble and test" have historically created confusion and misinterpretation of the intent of the regulation. For example, the space requirement for assembly and testing has often been interpreted to mean a separate "clean room" for engine assembly and testing following overhaul. The requirement to assemble and test in the AMTS environment is intended or necessary to train mechanics to a required standard, not to return a component to service. Therefore, in the AMTS, the space for disassembly, service, and inspection could be the same space used to assemble and test. Accordingly, § 145.15 is adopted as proposed.

Section 147.17 Instructional Equipment Requirements

The proposed revision to this section requires that the applicant's required instructional aircraft be fitted with navigation and communication (NAVCOM) equipment instead of the current requirement for a two-way radio.

Questions have been raised by two commenters concerning who would determine which type of NAVCOM equipment would be appropriate. The FAA's current procedure for determining the acceptability of radio equipment in AMTS remains unchanged. The language here only upgrades the two-way communications radio requirement to include an additional navigational equipment component.

The FAA is of the opinion that this new requirement should not be a cause of confusion as the revision is only a minor extension of the current rule. Accordingly, §§ 147.17 is adopted as proposed.

Section 147.19 Material, Tool, and Shop Equipment Requirements

The proposed revision to this section would eliminate the requirement that the AMTS must have an adequate supply of special tools and miscellaneous tools, and would require instead that the AMTS have an adequate supply of only those special tools that might be needed for such projects as engine assembly and calibration.

One commenter suggests that a list of minimum special tools be added and that there also be a clarification of who must provide handtools.

The FAA has determined that an additional explanation is not appropriate for regulations. Having a regulatory requirement for a list of minimum special tools would not serve any purpose since the quantity and type of special tools required would, in effect, be specified by the number of students being taught and the requirements of the instruction being received. As revised, §§ 147.19 provides more options to students and schools since the school is not required to provide handtools by regulation; then, either the student must provide them or the school may elect to supply them. The changes to § 147.19 are adopted as proposed.

Section 147.21 General Curriculum Requirements

The proposed rule changes several elements of this section. First, an amendment to § 147.21(b) would permit schools, at their option, to use a 50-minute instruction unit hour, the standard at most educational institutions.

One commenter opposes this change stating that the change would reduce classroom time, while three commenters recommend that it be adopted. Another commenter suggests that the FAA require that the hours offered by a school be clarified. No additional information was submitted concerning this suggestion.

The FAA also proposed to remove § 147.21(e). This would thereby give schools greater flexibility in allocating student time between practical and theory-based instruction. This would eliminate the current requirement that 50 percent of the total curriculum time be spent in shop or laboratory classes.

Six commenters are opposed to this change, preferring that the 50 percent shop time requirement be kept. Three other commenters indicate that this requirement should not be applicable to general aviation. No additional clarifying information was submitted concerning these three comments. The suggestion was put forward by one commenter that there be a specific split of 60 percent lecture and 40 percent laboratory.

The majority of the schools holding AMTS certificates under Part 147 are public institutions such as 2- and 4-year colleges. Almost without exception, the instruction unit for all subjects and disciplines at these institutions is 50-minutes in duration. This practice is currently in place at a number of privately owned part 147 MATS as well. During the public listening sessions preceding the NPRM, nearly every participant was in favor of defining a minimum 50-minute instruction time period. Based on the foregoing, the FAA has determined that no degradation in safety would result and that a 50-minute unit would be appropriate.

With respect to the removal of the existing requirement for 50 percent of the students instructional time to be in shop, most of the public listening session participants and the FAA agree that this requirement is obsolescent. Because of the complexity of modern aircraft systems, the FAA has determined that more classroom instruction time should be spent learning the cognitive skills associated with understanding the theoretical fundamentals of these complex systems, as opposed to requiring instruction in curricula structured to emphasize the development of certain traditional "hands-on" tactile skills, such as woodworking and heat treating.

In any case, the requirement for the development of manipulative and shop skills are retained at levels 2 or 3, because subject teaching levels require the appropriate amount of shop or laboratory instruction time. The changes to § 147.21 are adopted as proposed.

Section 147.23 Instructor Requirements

The proposed rule would permit schools to use specialized personnel who are not FAA-certificated mechanics to teach a wider variety of fundamental technical subjects. The proposal would provide the AMTS with a much larger pool of appropriately skilled and educated teachers from which to draw. The intent is to enable the AMTS to enhance the quality of education through the use of specialized instructors in certain general subjects without negatively affecting the quality of the instruction directly related to aviation maintenance subjects.

Several commenters suggest developing FAA standards for the specialized instructors and expanding the list of subjects that specialized instructors may teach. The development of standards for specialized instructors would be tantamount to requiring them to be certificated and is beyond the scope of this rulemaking. In addition, the commenters did not offer any rationale for expanding the list of subjects that the specialized instructors could teach. Accordingly, the FAA does not agree with these commenters and those proposals are not accepted.

Two commenters advocate dropping the term "similar subjects" from the list of subjects that specialized instructors may teach in order to avoid confusion. The FAA does not agree, because no evidence was put forward to suggest that the phrase "similar subjects" regarding instructor requirements in the current regulations does not provide sufficient instructor competence. In addition, by dropping that term, the list of specialized instructor privileges could grow to include virtually all non-aircraft maintenance related subjects. This may not provide appropriate instruction and could result in surveillance difficulties. The FAA has determined that the term "similar subjects" should be retained; this term adds clarity to the rule by defining the limitations of specialized instructors. Accordingly, § 147.23 is adopted as proposed.

Section 147.31 Attendance and Enrollment, Tests, and Credit for Prior Instruction or Experience

This section, under the proposal, would be amended to replace references to the term "mechanic" with the term "aviation maintenance technician."

Two commenters oppose this change without explanation. The FAA disagrees with the commenters; the occupation descriptor "aviation maintenance technician" is consistent with not only the title of the rule itself but is congruent with the current terminology of the aviation industry and the International Civil Aviation Organization.

Several commenters believe that a student should be eligible to receive credit for the subject of mathematics regardless of how that knowledge is gained. The FAA has not proposed changing the prerequisite in the current rule that verification and possibly testing are required before a school may credit a student for previous instruction or experience. This requirement applies to all subjects, including mathematics. The commenters offered no evidence that the informal study of mathematics is as effective and comprehensive as formal instruction. Thus, § 147.31 is adopted as proposed.

Section 147.35(a) Transcripts and Graduation Certificates

The proposed amendment to this section would make grade transcripts available to the student "upon request" to relieve a school of the burden of issuing unrequested or undesired transcripts.

One commenter opposes this change without explanation. The FAA does not agree with the commenter and has determined that the current requirement imposes an unneeded administrative burden on a certificated AMTS. The proposed change would relieve this burden without any adverse impact on safety. Accordingly, the amendment to § 147.35(a) is adopted as proposed.

Section 147.36 Maintenance of Instructor Requirements

Modifications to this section are similar to those proposed for § 147.23. These changes would permit the expanded use of instructors who are not certificated mechanics to teach certain subjects in the general curriculum.

As in § 147.23, several comments were received suggesting that the term "similar subjects" be dropped because it is vague and causes confusion. One respondent points out that the phrase "basis hydraulics" should be "basic hydraulics," while another indicates that the word "each" should be "teach."

The comments received regarding "similar subjects" for this section are congruent with those received in § 147.23, and the FAA has determined that the term "similar subjects" should be retained since it is adequately clear and provides the flexibility needed. The phrase "basis hydraulics" was a misspelling and will now read "basic hydraulics," and the word "each" was a misspelling and will now read "teach." With the exception of these changes, § 147.36 is adopted as proposed.

Section 147.38 Maintenance of Curriculum Requirements

No comments were received on the proposed changes to this section; therefore, § 147.38 is adopted as proposed.

Appendix A Curriculum Requirements

The proposed rule would add a paragraph (c) to this appendix to facilitate the use by AMTS of currently accepted educational materials and equipment, such as computers, calculators, and audiovisual equipment.

Part of the proposal relating to appendix A teaching levels (part 147, appendix A, section (b)(3)(ii)), replaces the term "accomplish" with "simulate." The proposal for this section will now read "Development of sufficient manipulative skills to simulate return to service."

A commenter states dissatisfaction with the proposed term "simulate" when training to level 3. The FAA disagrees with the comment, because while much of the training equipment in typical Part 147 AMTS may no longer be in airworthy condition; i.e., engines, generators, etc., sufficient manipulative skills may be developed and sufficient knowledge may be acquired on the training equipment to simulate the accomplishment of return to service even if the training equipment itself is not airworthy.

Another commenter proposed a change to appendix A, section (a), *Definitions*. The commenter suggests that section (a)(5) should read: " " 'Repair' means to correct a defective condition *by acceptable means*." The FAA disagrees. The commenter's suggestion could cause confusion in the definition of repair since the purpose of a part 147 school is to provide instruction in FAA acceptable methods and practices for all tasks. The FAA does not choose to adopt the comment "by acceptable means." Accordingly, the FAA adopts part 147, appendix A, as proposed.

Appendix B General Curriculum Subjects

The proposal adds both new material and changes teaching levels in certain subjects. The purpose of these changes would be to increase students' exposure to technical information and special skill requirements that are more relevant to the current aviation industry needs and to reduce required instruction time in certain obsolescent areas.

Several commenters suggest that the subject area "basic physics" be renamed as "basic science." The FAA disagrees. The subject of "basic science," which might include science subjects such as biology, zoology, etc., could be far less relevant than the more rigorously defined subject "basic physics." Basic physics encompasses the more applicable principles of fluids, air, heat, and mechanical forces which are more appropriate to the studies of AMT students.

Subject Item 30J

Two commenters suggest changing the phrase "develop principles" in part 147, appendix B, Subject Item 30J, Basic Physics, to "understand principles." The FAA agrees with the commenters. A requirement to develop physical principles would impose unreasonable and excessive technical requirements on AMTS students. The section has been revised to read: "Understand and use the principles of simple machines * * *"

Another commenter advocates inclusion of a requirement in this section concerning the use of typical aircraft maintenance records to emphasize mechanic responsibility. This was echoed by a commenter who suggests expanding the teaching section on maintenance forms, Subject Item 28, and requiring a student to develop the description of work performed as specified in §§ 43.9 and 43.11 and not just describe various discrepancies. The FAA agrees with both commenters. Appendix B, Subject Item 28, has been modified by adding the words: "Write descriptions of work performed including aircraft discrepancies and corrective actions using typical aircraft maintenance records."

Another commenter proposes that the teaching level for dye penetrant non-destructive inspection (NDI) be raised from level 2 to level 3. The FAA disagrees with this suggestion. All NDI training, including the use of dye penetrants, to a teaching level 3 competence clearly requires significant training beyond that which could reasonably be expected of an AMTS, given the time constraints imposed by other training requirements. Therefore, the FAA has not adopted this suggestion.

Several commenters recommend keeping heat treating processes at level 2 rather than dropping them to level 1. The FAA does not agree with those commenters. The complexities of today's aircraft structures require that greater emphasis be placed on fundamental and theoretical understanding of metallurgical materials and processes developed at teaching level 1 rather than requiring AMTS training to focus on the hands-on skills developed at teaching level 2. Note that in the final rule the word "inspect" is added at the beginning of the subject area description of subject item 23. This term emphasizes that a requirement to inspect for corrosion necessarily and logically precedes the identification, removal, and treatment of affected areas. Appendix B, therefore, is adopted in accordance with the changes to the NPRM as discussed.

Appendix C Airframe Curriculum Subjects

The proposed amendment to this appendix would add a subject area on composite aircraft structural inspection, testing, and repair as well as delete and reduce certain obsolescent material in some subject areas such as wood, dope, and fabric. Curriculum offerings would

be increased in certain current and newly emerging areas of technology and some teaching levels would increase.

Subject Item 50

Five commenters believe that the requirement in Subject Item 50 for teaching the troubleshooting and repair of constant speed drive (CSD) and integrated speed drive (ISD) generators at teaching level 3 is too high. They argue that the teaching of these systems at level 3 would present a significant economic burden to the majority of AMTS since this would require all schools to purchase at least one operating model of each type of generator at a considerable cost. Further, they argue that a satisfactory understanding of these systems may be simulated by alternative teaching methods that do not require the actual hardware.

After assessment of the alternatives, the FAA agrees with the comments and finds that the economic burden of acquiring this hardware is not justified. Following further study, the FAA agrees with the commenters that there are alternate methods available to teach those systems to a satisfactory level. Further, the original teaching level of 3 for ISD and CSD generating systems is unjustified with respect to the needs of industry, and it is more appropriate at a level 1. However, the needs of the aviation industry dictate that the teaching level should remain at level 3 for alternating and direct current generating systems. As a result of further evaluation, the FAA has determined that this subject item will be subdivided into two parts and will read as follows:

Item 50(a), teaching level 3, Inspect, check, troubleshoot, service, and repair alternating current and direct current electrical systems.

Item 50(b), teaching level 1, Inspect, check, and troubleshoot constant speed and integrated speed drive generators.

Accordingly, this section is adopted as revised by the foregoing discussion.

Subject Item 39

One commenter suggests removing the requirements in Subject Item 39 for instruction in "OMEGA" navigation systems since the system is primarily military and not in common use. With respect to this area, another suggestion was made to remove "OMEGA" and add "LORAN and Radar Beacon Transponders." The FAA agrees with the commenters, and this requirement has been modified in the final rule.

Subject Item 20

Another commenter suggests that the FAA consider modifying Item 20, to reduce the arc welding and soldering requirement from teaching level 2 to level 1. The FAA does not agree with this commenter. None of the participants at the FAA's public listening sessions identified any need for change in this area, and the commenter presented no rationale for the proposal.

Subject Item 8

Another commenter suggests expanding Subject Item 8 from "apply finishing materials" to include generic types of materials, such as polyurethane and other current types of material. While this suggestion has merit, expansion of this section is not necessary. A properly developed and administered curriculum with a teaching level of 2 would include instruction in aircraft painting using the current types of generic preparation, priming, and finishing materials.

Subject Item 33

Two commenters note that the teaching level for item 33, heating pressurization, etc., should be raised to level 2 since system components such as air cycle machines require frequent maintenance.

The FAA disagrees. The majority of the fault corrections involve either troubleshooting of circuitry or electromechanical devices. Appropriate analytical instruction can be delivered at the proposed teaching level 1 where basic principles and troubleshooting can be taught to the required knowledge level. In this case, the economic burden to the AMTS of acquiring the training equipment necessary to teach to a level 2 is not justified.

A single commenter believes that Subject Item 33 should include a warning about oxygen "danger aspects." The FAA has determined that this is not necessary since this subject is required to be taught at level 2 in Subject Item 35, and the oxygen system cautions and warnings subject must be taught as part of the curriculum.

Subject Item 51

One commenter believes that the language in Subject Item 51 describing "takeoff warning" systems should be changed to the more encompassing "configuration warning." The FAA agrees that this proposed language is more appropriate for the system description, and that phrase will be changed accordingly.

Subject Item 5

One commenter objects to Subject Item 5 being reduced to level 1. Subject Item 5 teaches the inspection, test, and repair of fabric and fiberglass cloth, a relatively obsolescent subject. The commenter gave no justification for the objection; however, much discussion in the FAA public listening sessions centered on the need to consider reduction of teaching levels in certain obsolescent subjects in order to liberate more instruction time to focus on subjects more relevant to today's needs.

The FAA has determined that sufficient knowledge may be gained on this subject at a teaching level 1 so that a student can be adequately trained to make appropriate repair judgments. Therefore, appendix C is revised as proposed.

Appendix D Powerplant Curriculum Subjects

Under the proposal, new subject material would be added to this appendix to increase the level of technical knowledge and skill required in the powerplant curriculum. Certain teaching levels would be changed to reflect the current and future technician training needs. Another major change to Appendix B would require that each certificated AMTS have an operating jet turbine engine for instructional purposes. This proposal is implicit in the hardware requirements for Subject Item 6, to "Inspect, check, service, * * * turbine engines and turbine engine installations."

Subject Item 19

Five commenters suggested that Item 19, "Inspect, service * * * turbine engine electrical and pneumatic starting systems," be divided into two sections, with electrical turbine engine starting systems being taught separately at level 3 and pneumatic turbine engine starting systems being taught at level 1. The reasons for the proposed division are primarily economic since teaching pneumatic starting systems at level 3 would require actual hardware. Pneumatic starting systems represent older technology and are becoming obsolete, so a reduction in teaching level could enable AMTS instruction to focus more productively on current turbine engine starting systems.

Another commenter recommends that the word "starting" be inserted after the word "electrical" to clearly identify the system being taught as a starting system. The FAA agrees that sufficient basis exists to incorporate these suggestions. Accordingly, Subject Item 19 is modified and adopted as follows:

a. Item 19(a), Inspect * * * troubleshoot * * * turbine engine electrical starting systems (at teaching level 3).

b. Item 19(b), Inspect * * * and troubleshoot turbine engine pneumatic starting systems (at teaching level 1).

Subject Item 20

The proposed revisions to this subject item would eliminate training in obsolete subjects; one such subject is Subject Item 20, requiring instruction in powerplant water injection systems. This requirement was discussed at length during the part 147 listening sessions. The FAA agrees that this technology is currently obsolete and applicable to relatively few aircraft, and instruction time could be more productively focused elsewhere. Two commenters suggest that this subject be retained at teaching level 1; however, sufficient justification was not presented, and the FAA does not agree with that suggestion. Therefore, this subject item is adopted as proposed.

Subject Item 6

During the listening sessions, both the FAA and most of the industry participants recognized and recommended that adequate training on turbine engine inspection, checking, and repair requires a turbine engine that is operational, and all operational training on this particular subject item, Item 6, should be at teaching level 3.

One commenter to the NPRM suggests that training on this item would be too complex at teaching level 3 and should be reduced to level 2. No economic justification or other basis was stated for the proposal to reduce the teaching level. The FAA disagrees. Accordingly, Subject Item 6 is adopted as proposed.

Subject Item 32

Under the current rule, this subject item is dedicated solely to the teaching of engine exhaust systems to teaching level 3. In the NPRM, it was proposed that this subject item be expanded to include the closely related subject of engine thrust reverser systems and related components. It was proposed and intended that this new subject be taught only to level 1. However, it was never intended that the current instruction in the repair and troubleshooting of engine exhaust systems be relaxed to teaching level 1. A relaxation of the teaching standard for engine exhaust systems generally would not be in the public interest, since improperly repaired exhaust systems could create a serious safety hazard. To make it absolutely clear that the current standard for this subject item is to be maintained, in the final rule the teaching of the repair of engine exhaust systems is separated from engine thrust reverser systems. The former is to continue to be taught to level 3, while the latter need only be taught to level 1. This subject item is subdivided into 32.a. (which employs the wording of current element 32) and 32.b., respectively.

Subject Item 40

Two commenters indicate that the newly added subject, Subject Item 40, Unducted Fans, be removed and that the subject material be incorporated into turbojet subject items. The FAA has determined that by placing the subject item, Unducted Fans, apart as a separate subject item, the subject may be taught more comprehensively when those systems enter service. Further, as that particular technology evolves, a separate instruction unit will provide some of the future AMTS curriculum growth potential that many commenters consider essential. Accordingly, appendix D, is adopted as proposed in the NPRM.

Miscellaneous Comments

A number of comments of a very general nature were received. The majority of these comments primarily address the proposed upgrading of sections of the curriculum specifying airframe systems such as communication and navigation systems, cabin atmosphere control systems, and similar subject items. These comments generally characterize the proposals as being too "airline oriented and watering down general aviation subjects." Some commenters warn against decreasing teaching levels in certain subjects more appropriate to general aviation; these include wood, dope, fabric, and radial engines.

The FAA will continue to assess demographic data, to determine where the bulk of AMTS graduates are employed, i.e., what knowledge, skills, and abilities are required of them. Currently, demographic information indicates that approximately 80 to 85 percent of AMTS graduates that are employed in the aviation industry are in airline or airline-related occupations. Further, long-range statistical demographic surveys indicate that aircraft maintenance technician migration into airline employment is likely to increase over the next decade. In view of these trends, the FAA is of the opinion that, for reasons of safety and commerce, AMTS would be able to maximize productivity if required curriculum provides an increased focus on the instruction necessary to increase student training in the knowledge, skills, and abilities required by the airline industry. On the other hand, the FAA has determined that the proposed regulatory changes will not result in a negative effect on AMTS training for general aviation since much of the same procedures and equipment required by the airline industry are already incorporated into many general aviation aircraft. Therefore, based on these considerations, those comments do not reflect the broader needs of the aviation community.

A number of commenters express concern that the scope of the revised regulation would require that all AMTS be recertificated by the FAA. The FAA is of the opinion that no AMTS will be required to be recertificated to conform to the rule. The FAA will continue to conduct routine conformity surveillance inspections to assure compliance with this rule.

Paperwork Reduction Act

Information collection requirements in the amendments to part 147 have previously been approved by the Office of Management and Budget under the provisions of the Paperwork Reduction Act of 1980 (Pub. L. 96–511) and have been assigned OMB Control Number 2120–0040.

Regulatory Evaluation Summary

Executive Order 12291, dated February 17, 1981, directs Federal agencies to promulgate new regulations or modify existing regulations only if potential benefits to society for each regulatory change outweigh potential costs. The order also requires the preparation of a Regulatory Impact Analysis of all "major" rules except those responding to emergency situations or other narrowly defined exigencies. A "major" rule is one that is likely to result in an annual effect on the economy of $100 million or more, a major increase in consumer costs, or a significant adverse effect on competition. The FAA has determined that this rule is not "major" as defined in the executive order, therefore a full regulatory analysis, that includes the identification and evaluation of cost reducing alternatives to this rule, has not been prepared. A more concise final regulatory evaluation has been prepared, however, which includes consideration of the economic consequences of this regulation. This regulatory evaluation is included in the docket.

Comments

The FAA received no comments directly discussing its regulatory

evaluation. However, five commenters argue that the proposed change to Appendix C (Airframe Curriculum Subjects), to teach repair of constant speed drive and integrated speed drive generators at level 3 (highest level), would impose too high a cost on AMTS. This amendment would require schools to purchase at least one operating model of each type of generator. The initial Regulatory Evaluation did not consider this cost. However, the FAA agrees with the commenters. The final rule does not include this proposed change, thus eliminating this cost.

Cost Impacts

The NPRM estimated a cost to AMTS related to the purchase of new equipment of $6,300 for about 30 schools under § 147.17. The FAA now estimates that all AMTS have the equipment to fulfill the new requirements under this section. This rule will add a cost burden to AMTS because of changes in appendixes B and D. Amendments to appendix B will require a higher teaching level in some fundamental general subjects, such as mathematics and physics. It lowers teaching levels in some obsolescent subjects, and it requires additional knowledge and skill levels on advanced subjects. The requirement includes teaching electronic repair of solid-state electronic equipment. The FAA estimates that 49, about one-fourth of the 196 certified AMTS, need to purchase new electronic equipment at an average cost of $5,270 per school. This results in a total cost of approximately $258,000.

In appendix D, the rule changes related to powerplant service and repair will require about one-sixth of AMTS to buy and mount a turbine engine; and it will cause about one-sixth of the schools to mount the turbine it owns. A fully mounted turbine engine costs about $74,000; setting up a turbine engine on an appropriate stand costs an average of $2,600. The cost of this section of the rule is approximately $2.5 million.

Cost Savings

Several amendments to part 147 will give AMTS a cost reduction. The amendment to § 147.5 permits a more efficient use of instructors because the rule will not require schools to predesignate which class a particular instructor must teach. This change is estimated to save the industry $1.1 million over the decade.

Changes to § 147.15 allow schools to use their existing classroom and laboratory areas more efficiently. While not affecting existing facilities, new applicants will need less space due to this amendment. Over the next 10 years, this should save new applicants a total of $1.3 million.

The amendment to § 147.21 permits schools to use a standard 50-minute instruction unit. This convention conforms with class time practice used at most educational institutions. Also, this section allows AMTS to teach material at a level equal to or higher than that designated in appendix A of part 147. Over the decade this savings amounts to $7.5 million for the industry by reducing administrative time requirements.

Amendments to §§ 147.23 and 147.36 permit schools to expand the use of instructors not certified as a mechanic to teach additional material in the general curriculum. This change will allow schools to use specialized personnel to teach math, physics, basic electricity, and similar subjects. The FAA determined that each school could replace one full-time-equivalent certificated mechanic instructor with an instructor not certified as a mechanic. With difference in annual salary of $7,400 between the two, the rule should save schools $16.8 million over the decade.

The amendment to § 147.31 gives AMTS more flexibility in crediting and testing, thus relieving some administrative burden. The rule permits schools to administer tests after a student completes a unit of instruction and give credit for the general curriculum courses previously taken at that school. Much of the amendment codifies existing practices. However, the greater flexibility reduces instructor time. The FAA estimates that two days a month of an instructor's time can be saved. This amendment will save AMTS $12.0 million over the decade.

Amendments to appendix B increase student exposure to fundamental concepts and new, up-to-date skill requirements of the aviation industry. They also delete certain obsolete requirements. By deleting outdated requirements, this amendment saves new AMTS from the purchase of $2,600 in heat treatment equipment no longer required. Over the decade, this saves the AMTS about $184,000.

Changes to appendix D increase the technical knowledge and skill requirements for the powerplant curriculum. The amendment eliminates the need of new schools to purchase radial engines which cost about $1,050 apiece. These amendments will save the AMTS about $74,000 over the decade.

Cost-Benefit Comparison

The cost decrease resulting from this rule will total $39 million over the decade. (This is equal to $23 million when discounted to 1990.) The largest savings come from the relaxation of the constraint to use certified mechanics for certain classes. This saves the industry $17 million over the next decade. In contrast, new requirements set down by this rule will cost the industry, public, and the FAA about $3 million over the next decade. The largest cost increase will come from the amendments to appendix D related to powerplant service and repair. To meet the rule requirements, a third of the schools will need to purchase or mount a turbine at a cost of more than $2.5 million. The following table outlines all of the rules costs and benefits.

TABLE 1.—SUMMARY OF COST INCREASE AND DECREASES

[Part 147 Revision Rule—Aviation Maintenance Technician Schools]

Section	What the amendment will do	Cost assumptions	Net savings
§ 147.5	Amendment eliminates requirement that certified teachers be listed as qualified for a given subject matter before teaching it. Requires AMT schools give the FAA only a list of FAA certificated instructors.	Save 16 hours annually for each school and one hour per school for the FAA.	$1.1 million.
§ 147.15	Eliminates requirement to overhaul engines to an airworthy condition for mechanics training. This will save new schools the expense of building or leasing building or leasing engine overhaul space.	Assumes 600 sq ft room; $30 per sq ft; 7 new schools per year.	1.3 million.
§ 147.17	Updates school aircraft requirements for navigation and communications equipment. FAA now estimates that all existing schools have the appropriate equipment to meet the requirements..	No cost impact	0.0
§ 147.19	Eliminates the reference to tools and requires the AMT schools to supply only special tools. Results in students purchasing standard tools at new schools.	No cost change to society sience cost only shift from schools to students.	0.0

TABLE 1.—SUMMARY OF COST INCREASE AND DECREASES—Continued

[Part 147 Revision Rule—Aviation Maintenance Technician Schools]

Section	What the amendment will do	Cost assumptions	Net savings
§ 147.21	Permits schools to use a standard 50-minute instruction unit. Also allows AMT schools to teach material at a level higher that designated.	Save administrative time	7.5 million.
§ 147.23 and § 147.36	Requirement will permit schools to expand the use of instructors who are not certificated mechanics to teach additional material in the general curriculum. Specialty teachers in math physics, etc. can be employed..	Cost difference between certificated and non-certificated teacher estimated at $7,000/yr. Savings for 196 accrue to schools..	16.8 million.
§ 147.31	Amendment will give testing flexibility to AMT schools	Cost savings based on a 2 days per month less for one instructor's time at each of 196 schools.	12.0 million.
§ 147.35	Amendment will alter wording so that the AMT schools need give students a transcript of grades only upon request.	Reduces cost but in an insignificant way	0.0
§ 147.38	Amendment gives AMT schools flexibility to teach subjects above the teaching levels required.	No economic impact	0.0
Appendix A	Amendment facilitates use of new teaching materials and equipment such as computers and teaching software.	Possible long term savings that are indeterminable..	0.0
Appendix B	Amendment will increase student exposure to fundamental concepts and updates skill requirements.	Cost of new equipment to existing schools is $5,300. New schools can save $2,600 on old equipment not required..	(65,000)
Appendix C	Amendment will add a subject area on composite aircraft structural inspection, testing, and repair as well as delete and reduce certain outdated material in subject areas such as wood and fabric. It will increase certain current and emerging areas of technology.	Changes will have little cost impact since no capital expenditures are needed.	0.0
Appendix D	Amendment will add new subject material requirements for powerplant curriculum. It also will require all certificated AMT schools to use an operating jet turbine engine for instructional purposes.	One-sixth need to buy turbine ($74,000) and one-sixth need to have a turbine mounted ($2,600).	(2.4 million).

In addition to a large net savings from this rule, the FAA believes that the amendment has certain nonquantifiable benefits. In particular, the amendments to § 147 will result in better trained aviation mechanics and the skills of AMTS graduates will better fit the needs of the airline industry.

The FAA has determined that this rule will give the industry a substantial cost reduction. Also, the AMTS will produce better trained mechanics with these changes.

Regulatory Flexibility Determination

The Regulatory Flexibility Act §§ 603(b) and 603(c) of 1980 (RFA) ensures that government regulations do not needlessly and disproportionately burden small businesses. The RFA requires FAA to review each rule that may have "a significant economic impact on a substantial number of small entities."

FAA criteria sets a "substantial number" as not less than 11 and more than one-third of the small entities subject to the amendment. This rule will affect 162 aviation maintenance technician schools. The threshold size for an AMTS is 150 employees. A significant economic impact for an AMTS is $28,350.

This rule will have significant economic impact on approximately one-sixth of the AMTS. This impact will come from the requirement to purchase a turbine engine at a cost of about $74,000. However, only one-sixth of the industry will experience this significant cost, well below the one-third required to meet the guidelines for a significant impact. The remaining schools will receive a cost savings of about $16,000 per year. This cost savings is below the $28,350 threshold. The FAA, therefore, has determined that this rule will not have a substantial economic impact on a significant number of small entities.

International Trade Impact Assessment

This rulemaking will have little long-term impact on trade opportunities for both American firms doing business overseas and for foreign firms doing business in the United States. All AMTS regulated by part 147 are in the United States. The AMTS do attract foreign students for study since the United States leads the world in aviation technology.

Federal Implications

The regulations herein would not have substantial direct implications on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that these regulations would not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

For the reasons discussed in the preamble, and based on the findings in the Regulatory Evaluation and the International Trade Impact Analysis, the FAA has determined that this final rule is not major under Executive Order 12291. In addition, the FAA certifies that this rule will not have a significant economic impact, positive or negative, on a substantial number of small entities identified under the criteria of the Regulatory Flexibility Act. This rule is considered significant under DOT Regulatory Policies and Procedures (44 FR 11034; February 26, 1979). The regulatory evaluation of this final rule, including a Regulatory Flexibility Determination and Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under **FOR FURTHER INFORMATION CONTACT.**

List of Subjects in 14 CFR Part 147

Aircraft, Airmen, Aviation safety, Aviation maintenance technician schools, Administrative and curriculum requirements, Educational facilities, Reporting and recordkeeping requirements, Schools.

The Rule

In consideration of the foregoing, the Federal Aviation Administration amends 14 CFR part 147 of the Federal Aviation Regulations as follows:

PART 147—AVIATION MAINTENANCE TECHNICIAN SCHOOLS

1. The authority citation for part 147 continues to read as follows:

Authority: 49 U.S.C. 1354(a), 1355, 1421, and 1427; 49 U.S.C. 106(g).

2. Section 147.5 is amended by revising paragraphs (a)(2) and (a)(3) to read as follows:

§ 147.5 Application and issue.

(a) * * *

(2) A list of the facilities and materials to be used;

(3) A list of its instructors, including the kind of certificate and ratings held and the certificate numbers; and

* * * * *

3. Section 147.15 is amended by revising paragraphs (a), (b), (c), (d), (f) introductory text, (g), and (h) to read as follows:

§ 147.15 Space requirements.

* * * * *

(a) An enclosed classroom suitable for teaching theory classes.

(b) Suitable facilities, either central or located in training areas, arranged to assure proper separation from the working space, for parts, tools, materials, and similar articles.

(c) Suitable area for application of finishing materials, including paint spraying.

(d) Suitable areas equipped with washtank and degreasing equipment with air pressure or other adequate cleaning equipment.

* * * * *

(f) Suitable area with adequate equipment, including benches, tables, and test equipment, to disassemble, service, and inspect.

* * * * *

(g) Suitable space with adequate equipment, including tables, benches, stands, and jacks, for disassembling, inspecting, and rigging aircraft.

(h) Suitable space with adequate equipment for disassembling, inspecting, assembling, troubleshooting, and timing engines.

4. Section 147.17 is amended by revising paragraph (a)(2) to read as follows:

§ 147.17 Instructional equipment requirements.

(a) * * *

(2) At least one aircraft of a type currently certificated by FAA for private or commercial operation, with powerplant, propeller, instruments, navigation and communications equipment, landing lights, and other equipment and accessories on which a maintenance technician might be required to work and with which the technician should be familiar.

* * * * *

5. Section 147.19 is revised to read as follows:

§ 147.19 Materials, special tools, and shop equipment requirements.

An applicant for an aviation maintenance technician school certificate and rating, or for an additional rating, must have an adequate supply of material, special tools, and such of the shop equipment as are appropriate to the approved curriculum of the school and are used in constructing and maintaining aircraft, to assure that each student will be properly instructed. The special tools and shop equipment must be in satisfactory working condition for the purpose for which they are to be used.

6. Section 147.21 is amended by revising paragraph (b) introductory text, paragraphs (c) and (d)(3), and by removing paragraph (e) to read as follows:

§ 147.21 General curriculum requirements.

* * * * *

(b) The curriculum must offer at least the following number of hours of instruction for the rating shown, and the instruction unit hour shall not be less than 50 minutes in length—

* * * * *

(c) The curriculum must cover the subjects and items prescribed in appendixes B, C, or D, as applicable. Each item must be taught to at least the indicated level of proficiency, as defined in appendix A.

(d) * * *

(3) A list of the minimum required school tests to be given.

7. Section 147.23 is revised to read as follows:

§ 147.23 Instructor requirements.

An applicant for an aviation maintenance technician school certificate and rating, or for an additional rating, must provide the number of instructors holding appropriate mechanic certificates and ratings that the Administrator determines necessary to provide adequate instruction and supervision of the students, including at least one such instructor for each 25 students in each shop class. However, the applicant may provide specialized instructors, who are not certificated mechanics, to teach mathematics, physics, basic electricity, basic hydraulics, drawing, and similar subjects. The applicant is required to maintain a list of the names and qualifications of specialized instructors, and upon request, provide a copy of the list to the FAA.

8. Section 147.31 is amended by revising paragraphs (b), (c)(1)(iv), (c)(3), and (e) and adding paragraph (c)(4) to read as follows:

§ 147.31 Attendance and enrollment, tests, and credit for prior instruction or experience.

* * * * *

(b) Each school shall give an appropriate test to each student who completes a unit of instruction as shown in that school's approved curriculum.

(c) * * *

(1) * * *

(iv) A certificated aviation maintenance technician school.

* * * * *

(3) A school may credit a student with previous aviation maintenance experience comparable to required curriculum subjects. It must determine the amount of credit to be allowed by documents verifying that experience, and by giving the student a test equal to the one given to students who complete the comparable required curriculum subject at the school.

(4) A school may credit a student seeking an additional rating with previous satisfactory completion of the general portion of an AMTS curriculum.

* * * * *

(e) A school shall use an approved system for determining final course grades and for recording student attendance. The system must show hours of absence allowed and show how the missed material will be made available to the student.

9. Section 147.35 is amended by revising paragraph (a) to read as follows:

§ 147.35 Transcripts and graduation certificates.

(a) Upon request, each certificated aviation maintenance technician school shall provide a transcript of the student's grades to each student who is graduated from that school or who leaves it before being graduated. An official of the school shall authenticate the transcript. The transcript must state the curriculum in which the student was enrolled, whether the student satisfactorily completed that curriculum, and the final grades the student received.

* * * * *

10. Section 147.36 is revised to read as follows:

§ 147.36 Maintenance of instructor requirements.

Each certificated aviation maintenance technician school shall, after certification or addition of a rating, continue to provide the number of instructors holding appropriate mechanic certificates and ratings that the Administrator determines necessary to provide adequate instruction to the students, including at least one such instructor for each 25 students in each shop class. The school may continue to provide specialized instructors who are not certificated mechanics to teach mathematics, physics, drawing, basic

electricity, basic hydraulics, and similar subjects.

11. Section 147.38 is amended by revising paragraph (a) to read as follows:

§ 147.38 Maintenance of curriculum requirements.

(a) Each certificated aviation maintenance technician school shall adhere to its approved curriculum. With FAA approval, curriculum subjects may be taught at levels exceeding those shown in Appendix A of this part.

* * * * *

12. Appendix A is amended by revising paragraph (b)(3)(ii) and by adding a new paragraph (c) to read as follows:

Appendix A to Part 147—Curriculum Requirements

* * * * *

(b) * * *

(3) * * *

(ii) Development of sufficient manipulative skills to simulate return to service.

* * * * *

(c) Teaching materials and equipment.

The curriculum may be presented utilizing currently accepted educational materials and equipment, including, but not limited to: calculators, computers, and audio-visual equipment.

13. Appendix B is amended by revising items 1, 3, 5, 7, 15, 16, 20, 23, 24, 25, 28, 30, and 31 to read as follows:

Appendix B to Part 147—General Curriculum Subjects

* * * * *

Teaching level	
(2)	1. Calculate and measure capacitance and inductance.
*	* * * *
(3)	3. Measure voltage, current, resistance, and continuity.
*	* * * *
(3)	5. Read and interpret aircraft electrical circuit diagrams, including solid state devices and logic functions.
*	* * * *
(2)	7. Use aircraft drawings, symbols, and system schematics.
*	* * * *
(2)	15. Perform dye penetrant, eddy current, ultrasonic, and magnetic particle inspections.
(1)	16. Perform basic heat-treating processes.
*	* * * *
(2)	20. Start, ground operate, move, service, and secure aircraft and identify typical ground operation hazards.
*	* * * *
(3)	23. Inspect, identify, remove, and treat aircraft corrosion and perform aircraft cleaning.
(3)	24. Extract roots and raise numbers to a given power.
(3)	25. Determine areas and volumes of various geometrical shapes.
*	* * * *
(3)	28. Write descriptions of work performed including aircraft discrepancies and corrective actions using typical aircraft maintenance records.
*	* * * *
(2)	30. Use and understand the principles of simple machines; sound, fluid, and heat dynamics; basic aerodynamics; aircraft structures; and theory of flight.
(3)	31. Demonstrate ability to read, comprehend, and apply information contained in FAA and manufacturers' aircraft maintenance specifications, data sheets, manuals, publications, and related Federal Aviation Regulations, Airworthiness Directives, and Advisory material.
*	* * * *

14. Appendix C is amended by revising items 2, 3, 5, 8, 10, 12, 16, 21, 25, 26, 33, 36, 37, 38, 39, 48, 50, 51, and 52, and the heading for Subject D under I. "Airframe Structures" to read as follows:

Appendix C to Part 147—Airframe Curriculum Subjects

*	* * * *
(1)	2. Identify wood defects.
(1)	3. Inspect wood structures.
*	* * * *
(1)	5. Inspect, test, and repair fabric and fiberglass.
*	* * * *
(2)	8. Apply finishing materials.
*	* * * *
	D. Sheet Metal and Non-Metallic Structures
(2)	10. Select, install, and remove special fasteners for metallic, bonded, and composite structures.
*	* * * *
(2)	12. Inspect, test, and repair fiberglass, plastics, honeycomb, composite, and laminated primary and secondary structures.
*	* * * *
(3)	16. Form, lay out, and bend sheet metal.
*	* * * *
(1)	21. Weld aluminum and stainless steel.
*	* * * *
(3)	25. Assemble aircraft components, including flight control surfaces.
(3)	26. Balance, rig, and inspect movable primary and secondary flight control surfaces.
*	* * * *
(1)	33. Inspect, check, troubleshoot, service, and repair heating, cooling, air conditioning, pressurization systems, and air cycle machines.
*	* * * *
(1)	36. Inspect, check, service, troubleshoot, and repair electronic flight instrument systems and both mechanical and electrical heading, speed, altitude, temperature, pressure, and position indicating systems to include the use of built-in test equipment.
(2)	37. Install instruments and perform a static pressure system leak test.
(1)	38. Inspect, check, and troubleshoot autopilot, servos and approach coupling systems.
(1)	39. Inspect, check, and service aircraft electronic communication and navigation systems, including VHF passenger address interphones and static discharge devices, aircraft VOR, ILS, LORAN, Radar beacon transponders, flight management computers, and GPWS.
*	* * * *
(2)	48. Repair and inspect aircraft electrical system components; crimp and splice wiring to manufacturers' specifications; and repair pins and sockets of aircraft connectors.
*	* * * *
(3)	50.a. Inspect, check, troubleshoot, service, and repair alternating and direct current electrical systems.
(1)	50.b. Inspect, check, and troubleshoot constant speed and integrated speed drive generators.
(2)	51. Inspect, check, and service speed and configuration warning systems, electrical brake controls, and anti-skid systems.
(3)	52. Inspect, check, troubleshoot, and service landing gear position indicating and warning systems.
*	* * * *

15. Appendix D is amended by revising items 1, 3, 6, 7, 9, 10, 18, 19, 20, 27, 32, and 35; by revising the headings for Subjects E, H, and J under II. "Powerplant Systems and Components"; by adding a new item 39 under II, heading K "Propellers"; and by adding two new subject headings, heading L, "Unducted Fans" consisting of item 40, and heading M, "Auxiliary Power Units" consisting of item 41, to read as follows:

Appendix D to Part 147—Powerplant Curriculum Subjects

* * * * *

Teaching level	
(1)	1. Inspect and repair a radial engine.
* * * * *	
(3)	3. Inspect, check, service, and repair reciprocating engines and engine installations.
* * * * *	
(3)	6. Inspect, check, service, and repair turbine engines and turbine engine installations.
(3)	7. Install, troubleshoot, and remove turbine engines.
* * * * *	
(2)	9. Troubleshoot, service, and repair electrical and mechanical fluid rate-of-flow indicating systems.
(3)	10. Inspect, check, service, troubleshoot, and repair electrical and mechanical engine temperature, pressure, and r.p.m. indicating systems.
* * * * *	
	E. Ignition and Starting systems
* * * * *	
(2)	18. Inspect, service, troubleshoot, and repair reciprocating and turbine engine ignition systems and components.
(3)	19.a. Inspect, service, troubleshoot, and repair turbine engine electrical starting systems.
(1)	19.b. Inspect, service, and troubleshoot turbine engine pneumatic starting systems.
(1)	20. Troubleshoot and adjust turbine engine fuel metering systems and electronic engine fuel controls.
* * * * *	
	H. Induction and Engine Airflow Systems
* * * * *	
(1)	27. Inspect, check, service, troubleshoot and repair heat exchangers, superchargers, and turbine engine airflow and temperature control systems.
* * * * *	
	J. Engine Exhaust and Reverser Systems
* * * * *	
(3)	32.a. Inspect, check, troubleshoot, service, and repair engine exhaust systems.
(1)	32.b. Troubleshoot and repair engine thrust reverser systems and related components.
* * * * *	
(1)	35. Balance propellers.
* * * * *	
(3)	39. Repair aluminum alloy propeller blades.
	L. Unducted Fans
(1)	40. Inspect and troubleshoot unducted fan systems and components.
	M. Auxiliary Power Units
(1)	41. Inspect, check, service, and troubleshoot turbine-driven auxiliary power units.

Issued in Washington, DC, on June 22, 1992.

Barry Lambert Harris,

Acting Administrator.

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